Vehicular Ad-Hoc Networks (VANETs) for Vehicle Tracking

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ABSTRACT:

Vehicular Ad-hoc Networks (VANETs) are self-organized networks built up from moving vehicles, and are part of the broader class of Mobile Ad-hoc Networks (MANETs). VANETs require the definition of specific networking techniques, whose feasibility and performance are usually tested by means of simulation. The main challenges posed by VANETs simulation are their faithful characterization and physical implementation. Logistic difficulties, economic issues and technology limitations, Economic issues and technology limitations make simulation the mean of choice in the validation of networking protocols for VANETs and a widely adopted first step in development of real world technologies. It is quite interesting to bring down complexities of VANETs in realization of their characteristics both in simulation as well as real-time implementation by defining VANET for a number of vehicles and base-stations for their tracking applications within the geographic scenario specified by the service provider.

1.INTRODUCTION:

Ad-hoc networking is currently a very active area of research, yet evaluating the many proposed protocols for Ad-Hoc networks remains difficult. In an ad hoc network, wireless nodes cooperate to form a network, forwarding packets for each other to allow nodes not within direct wireless transmission range of each other to communicate. The behavior of the system can be quite dynamic due to factors such as node movement and variations in radio propagation conditions, creating frequent changes in network topology, differing concentrations in traffic load on the network, and other challenges to the operation of the network protocols.

Vehicular Ad-hoc Networks (VANETs) represent a rapidly emerging, particularly challenging class of Mobile Ad-hoc Networks (MANETs). VANETs are distributed, self organizing communication networks built up from traveling vehicles, and thus characterized by very high speed and limited degrees of freedom in nodes movement patterns. Such particular features often make standard networking protocols inefficient or unusable in VANETs, and this combined with huge impact that the deployment of VANET technologies could have on the automotive market, explains the growing effort in the development of communication protocols which are specific to vehicular networks.

VANETs have some similar characteristics to MANETs, e.g. short radio transmission range, low bandwidth, omni directional broadcast and limited storage capacity.

VANET meets some particular challenging characteristics:

1. Rapid topology changes;
2. Frequent network partition;
3. Small effective network diameter
4. Limited redundancy in time and in function.
5. Position Predictability
6. Relatively sufficient power.

Position predictability and relatively sufficient power may be utilized to give support to vehicle-to-roadside communication, while rapid topology changes, frequent network partition, small effective network diameter and limited redundancy in time and in function aggravate the difficulties to communication in VANETs.

Whereas it is crucial to test and evaluate protocol implementation in real test bed environments. Logistic difficulties, economic issues and technology limitations make simulation the mean of choice in the validation of networking protocols for VANETs. A critical aspect in a simulation study of VANETs is the need for a mobility model, which reflects, as close as possible, the real behavior of vehicular traffic. When dealing with vehicular mobility modeling, we distinguish between macro-mobility and micro-mobility descriptions [1]. Many non-specific mobility models employed in VANETs simulations may not reproduce peculiar aspects of vehicular motion, such as car acceleration and deceleration in presence of near by vehicles, queuing at road intersections, vehicle congestion and traffic jams.

Physical protocol implementation allows the real system itself to be measured and can help to validate simulations, Physical implementation deal with real packet formats and application programming interfaces, whereas such factors can be simplified and abstracted in simulation. In addition, evaluations using physical implementation are generally time-and equipment-intensive than simulations, due to the use of real hardware and real mobility and exposure of the experiments to the real environment in which this mobility takes place.

Simulation and physical implementation are each valuable as techniques in evaluating ad-hoc network protocols, and any complete evaluation should include both, resulting in extra effort in coding, debugging, validation, and maintenance.

2. RELATED WORK:

Simulation models of many ad-hoc network routing protocols including VANET have been created in simulators such as ns-2, GloMoSim[2], OPNET[3], and QualNet [4], VanetMobiSim [5] and several of these protocols have also been implemented in physical environments. But VANET as of now not realized in real time because of many factors as stated in section 1. In most of the wireless protocol implementation simulation plays a significant role, in this proposed work we use two simulators ns-2 and SUMO[6] extensively for network and traffic data simulations respectively. It is also important to look for an adequate, high performance traffic simulation tool accounting for the vehicle movement within the geographic scenario. Besides network simulations, a well-designed traffic simulation is also essential to successfully simulate VANETs applications. A few projects exist treating of traffic simulation. CORSIM [7] is one of the most widely used microscopic vehicle traffic simulations. As a microscopic conceptual simulation, CORSIM traces and represent individual action of each vehicle.

. Bonn-Motion can generate simple vehicle movement patterns that are used as trace files in network simulators. Vissim [8] provides an implementation to approximate urban vehicle movement using a microscopic simulation approach. It is developed by Java language. SUMO is designed To provide a common platform for testing and comparing models of vehicle behavior, traffic light optimization, routing etc. SUMO exploits microscopic, space-continuous, and time-discrete car-following model to implement vehicle movements. STRAW [9] is built upon JiST/SWANS network simulation. It provides a vehicular mobility model by usage of map data and limits their mobility according to vehicular congestion and simplified traffic control mechanisms.

The mobility model of vehicular nodes is one of the most significant factors that impact the results of VANETs evaluation by making use of this simulation. Thus we should try to make the motion of simulated vehicles similar to the way of vehicles perform in the real world. A realistic mobility model facilitates to produce accurate results reflecting the practical performance of a VANET. The primary objective of this simulation is to perform and evaluate a new MAC protocol. Therefore, the simulation focuses on the fashion of message exchanging and the management of simulation time. To achieve that aim, we should pay a detail attention to the behavior of individual vehicle in a small-scale traffic scenario. The vehicular behavior contains not only the way of movement but also the manner of sending and receiving messages.

However physical implementation for other Ad-hoc protocols followed basically three approaches as listed below.

1. For creating a new physical implementation of some protocol is to base the new implementation on the existing code of a simulation model of the same protocol. For example *ns-2* [10] simulation model of the AODV routing protocol as the basis for a new physical implementation of the protocol in Linux, however the implementation is not directly portable between different operating systems and supports only AODV [11] protocol.
2. Merging simulation and physical implementation efforts is the use of an existing physical implementation of some protocol as the basis for a new simulation model of the same protocol [12].
3. Use of existing, unmodified protocol simulation models to create new physical protocol implementations. Unlike network emulation systems [13,14,15] this approach resulting physical protocol implementations

are entirely real, not simulated. Whereas emulation systems simulate some aspects of the network behavior, make collection of stationary, wired nodes perform as if they were mobile and wireless, the physical protocol implementation produced from simulation code here run entirely on real hardware, with real packets and real wireless network interfaces; when executed no aspect of the network and protocol performance is simulated, making the implementation suitable for detailed, realistic protocol testing and performance evaluation or for even possible production application. This approach supports protocol models from the widely used *ns-2* network simulator, rather than requiring use of new implementation environments, and thus retain all the benefits of *ns-2* simulations, such as rapid prototyping and a widespread user community. Existing protocol modules can easily be used to create new physical implementations, and new protocols or modifications to existing protocols can easily be coded and tested in both simulation and physical implementation. This approach does support portability to other protocol simulation systems.

3. PROPOSED WORK AND SYSTEM CONCEPT:

The basic system concept constitute three major components called Traffic Simulator, Network Simulator and Application software to couple two Simulators, for initial simulation set up and data exchange. The Application software called *Trans* version 0.1 is used to establish client/server connectivity for Simulators.

The simulation environment set up for this work consists of three logical components. The first one is represented by a traffic simulator, which periodically computes new positions for vehicles within a specific geographical scenario.

3.1 *Traffic Simulation Variations*:

Based on different sampling scales and the Level of detail in representing the state of traffic systems, traffic simulations can be categorized into macroscopic, mesoscopic and microscopic simulations. Macroscopic simulation treats traffic as continuous flow, while mesoscopic simulation models individual vehicles on an aggregate level and pays attention to some integral factors, i.e. traffic throughput.

In contrast to macroscopic and mesoscopic simulation, microscopic simulation concentrates on capturing the behavior of vehicles in detail. Accordingly, macroscopic and mesoscopic simulation are both weak to instantaneously respond to changes in modeling traffic system, whereas microscopic simulation models can better simulate the spatio-temporal changes of vehicles individually. Furthermore, the rapid advancement of computer processors helps address the suspicion on the consumption of computational capabilities in microscopic simulation.

A network simulator constitutes the second component, which is dedicated to imitating the full functionality of a real wireless network with all its complex effects of mobile communications. The network simulator must permanently be notified about the positions of the vehicles that participate in the network in order to have the current connectivity pattern available. There are certain important criteria when choosing an adequate tool, besides a comprehensive model for mobile wireless networks, a representation of specific effects like shadowing caused by building in urban areas or radio wave reflections due to roads and building walls must be readily available and adjustable within a convenient simulator. Proper antenna models with adjustable transmit powers and reception thresholds are necessary in order to reproduce the properties of the real wireless modules built into prototyping cars.

An appropriate network simulator also has to implement the widely accepted communication standard IEEE 802.11, in the following called WLAN, which specifies both the physical and the Medium Access Control (MAC) layer of the OSI network architecture. WLAN has become the prevailing wireless transmission technology in the field of VANETs due to low sensitivity high velocities, sufficient transmission ranges and fast connection times. Besides a comprehensive model for mobile, wireless multi-hop networks and the implementation of the WLAN communication standard, a possibility for including or attaching data exchange modules must be provided. Extension like the implementation of a completely new network node behavior must be possible as well. Of particular important factor in ns2 is that of propagation models under ns2, and hence its effect on following.

1. ***MAC layer***: Concerning the data rate, by default ns-2 considers two throughputs. The basic rate for the signaling messages is of 1Mb/s and the data messages rate is of 2Mb/s. The throughput is fixed in ns-2. However, the IEEE 802.11b interface cards have a fixed and automotive mode. In the automotive mode, it is possible to have multiple data rates (1Mb/s, 2Mb/s, 5.5Mb/s, and 11Mb/s), and different corresponding encoding techniques. Thus, the automatic mode adopts the throughput and the encoding technique to counter the expected loss rate. This optimizes the overall throughput according to the communication range.

2. ***Multi Data Rate Algorithms***: Automatic algorithms for data rate selection allow choosing the optimum throughputs. The ARF (Auto Rate Fallback) algorithm was one of the first developed [16]. It uses the packets loss rate to choose its throughput. If many data packets are lost, it decreases its throughput and symmetrically, increases the throughput following several positive receptions. A receiver-based auto-rate (RBAR) obtains good results [17]. RBAR uses RTS/CTS mechanism to select its throughput. Before each transmission the node sends an RTS message. The base station detects the received signal power of this message, compares this value to the thresholds, and chooses the suitable throughput from the experiment based database table values. This choice will be placed in the CTS message, and the base-station transmitter will be able to send its data message with the recommended throughput. These thresholds can change according to the commercial 802.11b cards.

3. ***Simulation of the modified MAC layer***: The MAC layer is modified to include RBAR feature. There are many other challenges involved in obtaining a specific propagation model for each type of roads and hence increasing precision of simulations, in other words the empirical model of propagation depends upon the experimental database data-rate values. This results in proper integration of simulator functions, which return the received power according to the distance between vehicles and base-station.

The third and last component for controlling the whole simulation environment. Representing the same behavior for all vehicles, it evaluates received messages and locates the vehicle by the traffic simulator.

In this work the simulation complexity involves details of vehicles other than its speed and its routing, this two requirement simplifies VANETs simulation and further real-time implementation call for stringent protocol requirements as we shall be using system architecture shown in Fig.3, which operates on existing unmodified simulation module. For the real time implementation we use the method followed in Ad-Hoc network protocol [18], which has all the benefits, required by the network as well as operating system. Further this protocol implementation resolves compatibility issues among the different operating systems also supports almost all simulation environment.

The schematic used for VANETs and Simulator Coupling is illustrated in Fig.1 and Fig.2 respectively.

The Physical implementation makes use of both architectural and simulator advantage for wireless protocols with salient features listed below, Fig.3.

1. The architectural feature include,
2. Kernel-Level Support
3. User-Level Support
4. Architectural Portability
5. Operating System Portability

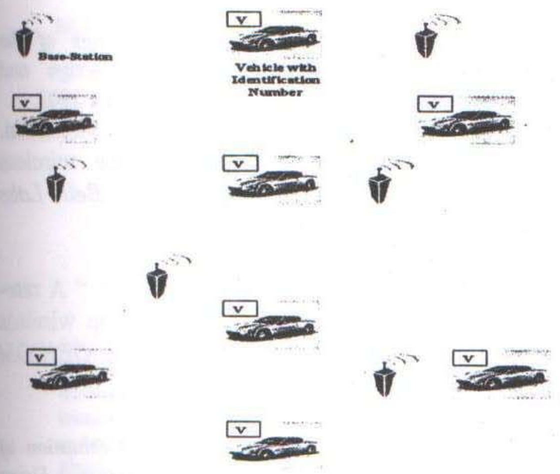

FIG.1.SCHEMATIC OF VEHICLE AD-HOC NETWORK CONSISTING OF BASE-STATIONS AND VEHICLES

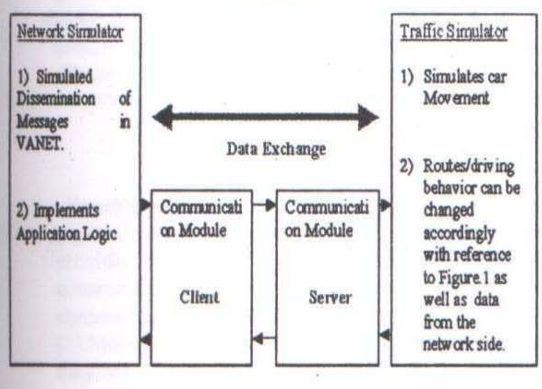

FIG.2. COUPLING BETWEEN TWO SIMULATORS

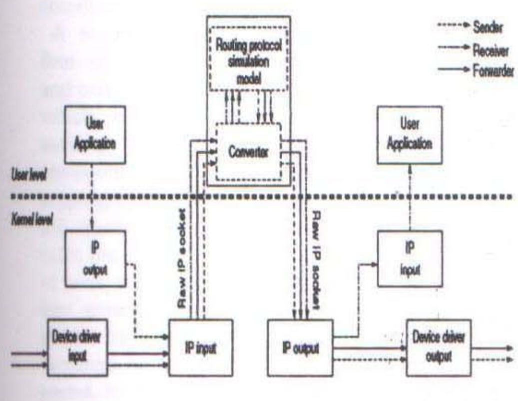

FIG.3. FLOW OF A PACKET THROUGH A NODE IN DIFFERENT SCENARIO IN PHYSICAL IMPLEMENTATION

4. SIMULATION:

The simulation scenario described is within the environment of ns-2 and SUMO and the data exchange mechanism involved, Fig.1. This was tested over more than 200 vehicles within a radius of 4 square Kms with a communication range of 200m has been applied. Most of the vehicles under test shall be wireless enabled.

Whenever a vehicle is out of the defined scenario the server sends a warning to the client to which the client has to acknowledge and at the same time if a vehicle is within the defined geographical scenario and not in the position where the client had left the vehicle, the client communicates with the service provider to locate the vehicle so as to retrieve from the dislocated position.

5. CONCLUSION:

This paper provides an overview of coupling a network with traffic simulator. With such a simulation environment communication of tracking vehicles within the geographical scenario can be investigated in detail, which is crucial when the vehicle is out of the geographical scenario and displacement of vehicle within the scenario, which evaluates the vehicular safety of the clients.

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